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## EUROPEAN PATENT APPLICATION

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### ④ Plastics materials for wall structures.

⑤ The invention relates to a plastics material especially suitable for the hull of a water-borne craft. The material is in the form of a three-layer sandwich, in which plastics is used as the basic material of the inner layer (3) and the outer layer (1) of the hull with some additive and filler incorporated therein, and plastics is also used as the basic material of the middle layer (2) of the hull with additive and reinforcing material incorporated therein. The hull is produced by rotating modelling and has an excellent bulk property, toughness and impact resistance. The wall structure according to the invention is not only suitable for producing larger craft, but also for producing various wall structures such as vehicle shells, boat bridges, various containers, boxes and parts of buildings for instance removable rooms.

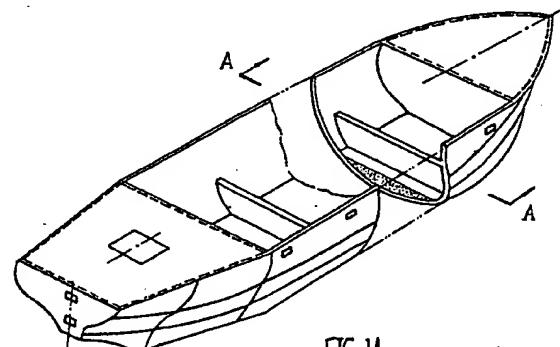


FIG 1A

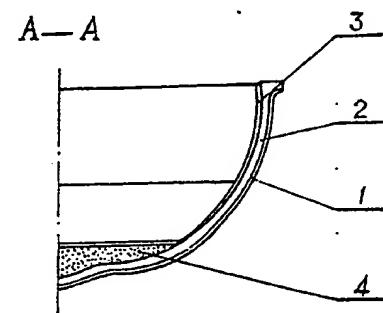


FIG 1B

### Plastics materials for wall structures

The present invention relates to plastics materials, especially for the hulls of water-borne craft and other wall structures, and to a process of making the same.

Materials are currently employed for the hulls of water-borne craft with properties such as low weight, high corrosion resistance and high impact resistance. Some traditional vessels are still made of lumber, steel, cement or glass-fibre reinforced plastics. U.S. Patent No. 3 150 386 for example disclosed a portable watercraft made of foam plastics and reinforced by a light inner armature, which confers rigidity to the foam plastics and prevents breakage of the same. U.S. Patent No. 2,743,465 disclosed a ship body comprising an exterior and an interior layer of plastics over wooden planks. Also U.S. patent No. 3,176,055 described a ship hull, wherein a layer of plastics foam was sandwiched in between an inner and an outer plastics layer in order to reduce the inherent weight of the ship hull.

These conventional hulls have a corrosion resistance improved to some extent, with reduced inherent hull weight and increased impact resistance but they have a poor bulk property and are not suitable to be produced in a large size. In addition their manufacturing is somewhat complex.

A main object of the invention is to provide a plastics material which can be used in hulls of waterborne craft, resulting in an improved bulk property, increased toughness, and increased impact resistance of such hulls, and which will enable larger craft to be produced in such materials, for examples craft up to 15 metres in length.

According to one aspect of the present invention a plastics material for a wall structure comprises a three-layer sandwich comprising an inner layer and an outer layer of a basic plastics material including additive material and filler material, and a middle layer of a basic plastics material including additive material and reinforcing material.

This material is suitable for the walls of larger hulls and has excellent toughness and impact resistance. The resultant hull also has an excellent bulk property.

The plastics material of this invention can be used in various wall structures such as those of shells including vehicle shells, casings, tanks, boat bridges, containers including rubbish boxes, and parts of buildings including removable rooms.

According to a further aspect of the invention a process for producing a wall structure comprises placing plastics material into a metal container-type die for the wall structure, driving the die on a swing frame so as to have an inclined movement relative

to the stationary horizontal orientation of the die, and heating the die to an elevated temperature, whereby a layer of plastics material, is formed over the die, and repeating these steps according to the number of layers required.

The use of rotating modelling process technology solves the problems of poor plastics conformability and poor bulk property of the resultant hull, and also reduces the production cost.

An embodiment of the invention will now be described in detail by way of example and by reference to the drawings, in which:

Figure 1A is a schematic perspective view of a hull of a water-borne craft made from material according to the invention;

Figure 1B is a part-sectional view taken along A-A of Figure 1A; and

Figure 2 is a sectional view of a rotary modelling machine used in the process of producing the hull of Figures 1A and 1B.

The hull of a boat has a three-layer sandwich structure, wherein 1 denotes an outer layer of the ship hull, 2 a middle layer of the hull, 3 an inner layer, with a plastics foam layer 4 in the bottom of the hull.

Polyethylene (PE) is used as the basic material of the outer layer 1, in which additive and filler are incorporated so as to physically improve the material. Suitable additives enhance the durability of the plastics material, for example common ageing resistants and ultraviolet radiation resistants.

The filler is a mixture of the following components: silicon dioxide, ferric sulphate, carbon black, titanium dioxide, zinc oxide, calcium carbonate, molybdenum sulphide, and aluminium oxide. The weight of the filler obtained by mixing the above-mentioned components is equal to 10-30% of the weight of the outer layer of the hull.

Polyethylene (PE) is also used as the basic material of the middle layer 2 of said hull, with a selection from the above-mentioned additives, and also reinforcing material(s) 6 for example glass fibre, asbestos fibre, mineral cotton fibre and rock cotton fibre, carbon fibre or other short fibres, metal filament, metal network or other metal structural element. The total weight of said reinforcing material(s) is preferably equal to 10-50% of that of the said hull's middle later. This middle later is the reinforcing layer and plays an important role in improving the bulk property of said hull.

The material of the inner layer 3 of said hull is the same as the outer layer thereof e.g. polyethylene as the basic material with additives and fillers, again 10-30% of the weight of the inner layer, incorporated therein, so as to physically modify the

plastics material.

Furthermore, a surface garnishing process of said layers may be used to meet the different requirements of many kinds of hulls for producing a satisfactory inner surface. Plastics foam may be filled into the space between the hull bottom and shell plates from stern to stern and into the float cabin in order to reduce the inherent weight of the hull.

The wall structure according to the invention is not only suitable for producing ship hulls, but also for producing various vehicle shells, boat bridges, various containers, storage tanks, rubbish boxes, removable rooms, and the like.

The manufacture of the material is now described.

Referring to Figure 2, 5 denotes a container-type die set of the hull; 6 rotating modelling machine, 7 swing frame, and 8 flame jet nozzles. The physically modified plastic materials where polyethylene is used as the basic material are put into a container-type metal-made die set of the hull 5. Said die set 5 is driven to rotate on a swing frame 7 and to have an inclined movement relative to horizontal orientation of said hull by way of a rotating modelling machine 6. In the meantime, said die set is heated up to a temperature in the range 200 °C - 400 °C by several lines of flame jet nozzles 8, so as to make said physically modified plastics materials evenly spread on the inner wall of said die set for forming the outer layer of the boat hull.

In the same way PE as the basic material mixed homogeneously with additive and reinforcing material (10-50% in weight) is put into the die set, which is rotated and heated to make these materials homogeneously mixed and evenly spread on the exposed surface of the hull's outer layer, so as to form the middle layer, i.e. the reinforcing layer of the boat hull.

Similarly as above mentioned, polyethylene is mixed to incorporate additive and filler (10-30% in weight) therein, so as to obtain a physically modified plastics. Said plastics then is put into the die set which is rotated and heated so that the modified plastics is evenly spread onto the exposed surface of said middle layer to form the inner layer of the boat hull.

The additive(s), filler(s) and reinforcing material(s) in each layer can be selected so as to meet the specific different requirements of performance of the hull.

The boat hull to be obtained according to the process mentioned above is demoulded at a temperature below 40 °C. Then plastics foam is filled into the space between the boat bottom and shell plates from stern to stern and also into the float

cabin and so on. Other necessary parts and means made of plastics can be added to the hull to form a predominantly or totally plastics craft.

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## Claims

1. A plastics material for a wall structure, comprising a three-layer sandwich comprising an inner layer (3) and an outer layer (1) of a basic plastics material including additive material and filler material, and a middle layer (2) of a basic plastics material including additive material and reinforcing material.
- 10 2. A material as defined in claim 1, wherein the basic plastics material is polyethylene.
- 20 3. A material as defined in claim 1 or 2, wherein the filler used in both the inner and outer layers is a mixture including the following components: silicon dioxide, ferric sulphate, carbon black, titanium dioxide, zinc oxide, calcium carbonate, molybdenum sulphide and aluminium oxide.
- 25 4. A material as defined in claim 3, wherein the weight of the filler used in said inner and outer layers is equal to 10% - 30% of the total weight of each of said inner and outer layers.
- 30 5. A material as defined in any of claims 1 to 4, wherein the reinforcing material of the middle layer is selected from any of glass fibre, asbestos fibre, mineral cotton fibre, rock cotton fibre, metal filament, metal network and metal structural element.
- 35 6. A material as defined in claim 5, wherein the weight of said reinforcing material is equal to 10%-50% of the total weight of said middle layer.
- 40 7. A water-borne craft having a hull made from plastics material according to any of claims 1 to 6.
- 45 8. A craft as defined in claim 7, wherein the material of the hull solely consists of the plastics material.
- 50 9. A process for producing a wall structure, comprising placing plastics material into a metal container-type die for the wall structure, driving the die on a swing frame so as to have an inclined movement relative to the stationary horizontal orientation of the die, and
- 55 heating the die to an elevated temperature, whereby a layer of plastics material is formed over the die, and repeating these steps according to the number of layers required.
10. A process as defined in claim 9, wherein the wall structure is demoulded at a temperature below 40 °C.
11. A process as defined in claim 9 or 10, wherein the temperature range at which said die is rotated and heated is 200 °C to 400 °C.
12. A process of making a hull of a water-borne craft, as defined in claim 9, 10 or 11.

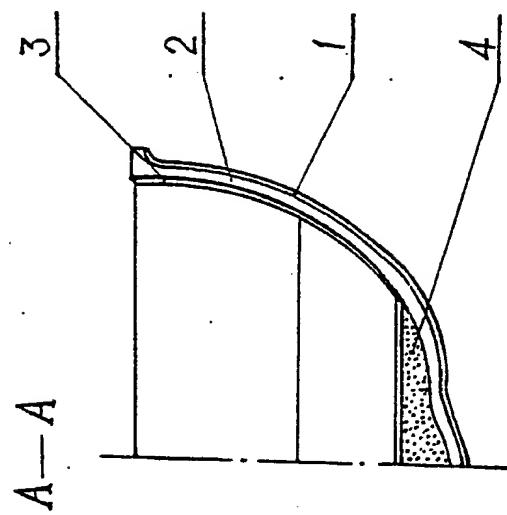


FIG 1B

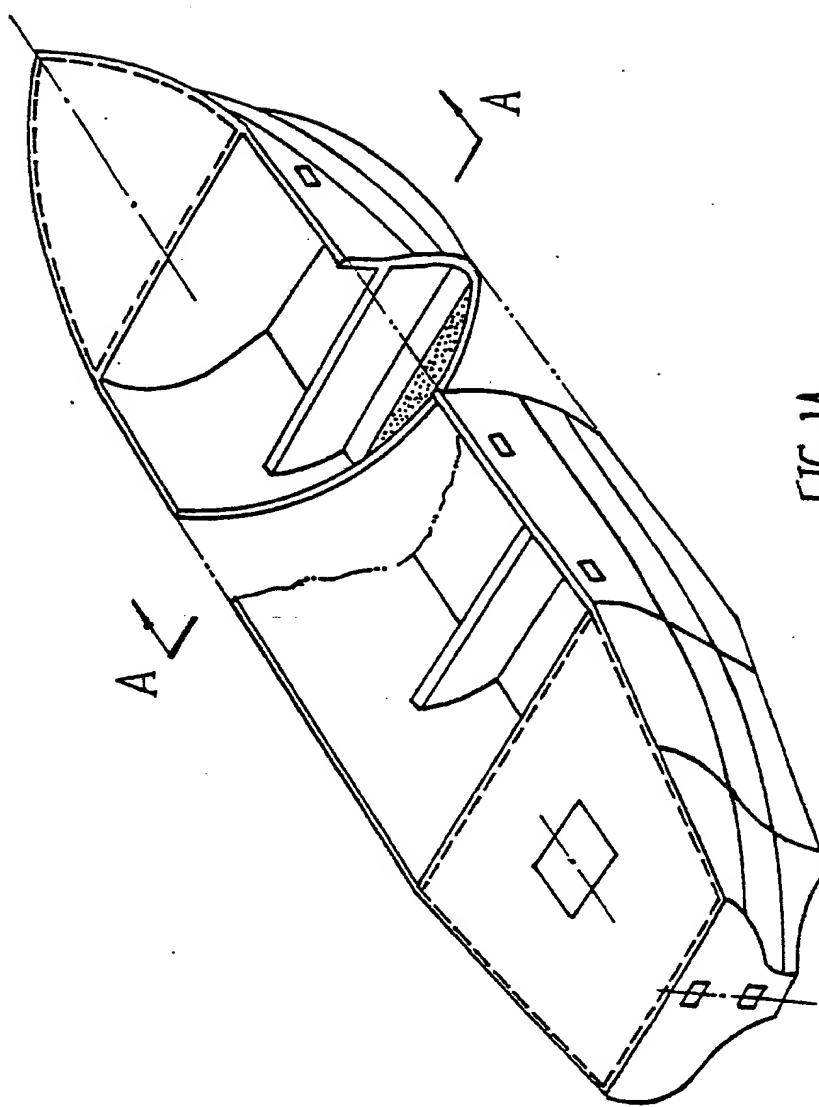


FIG 1A

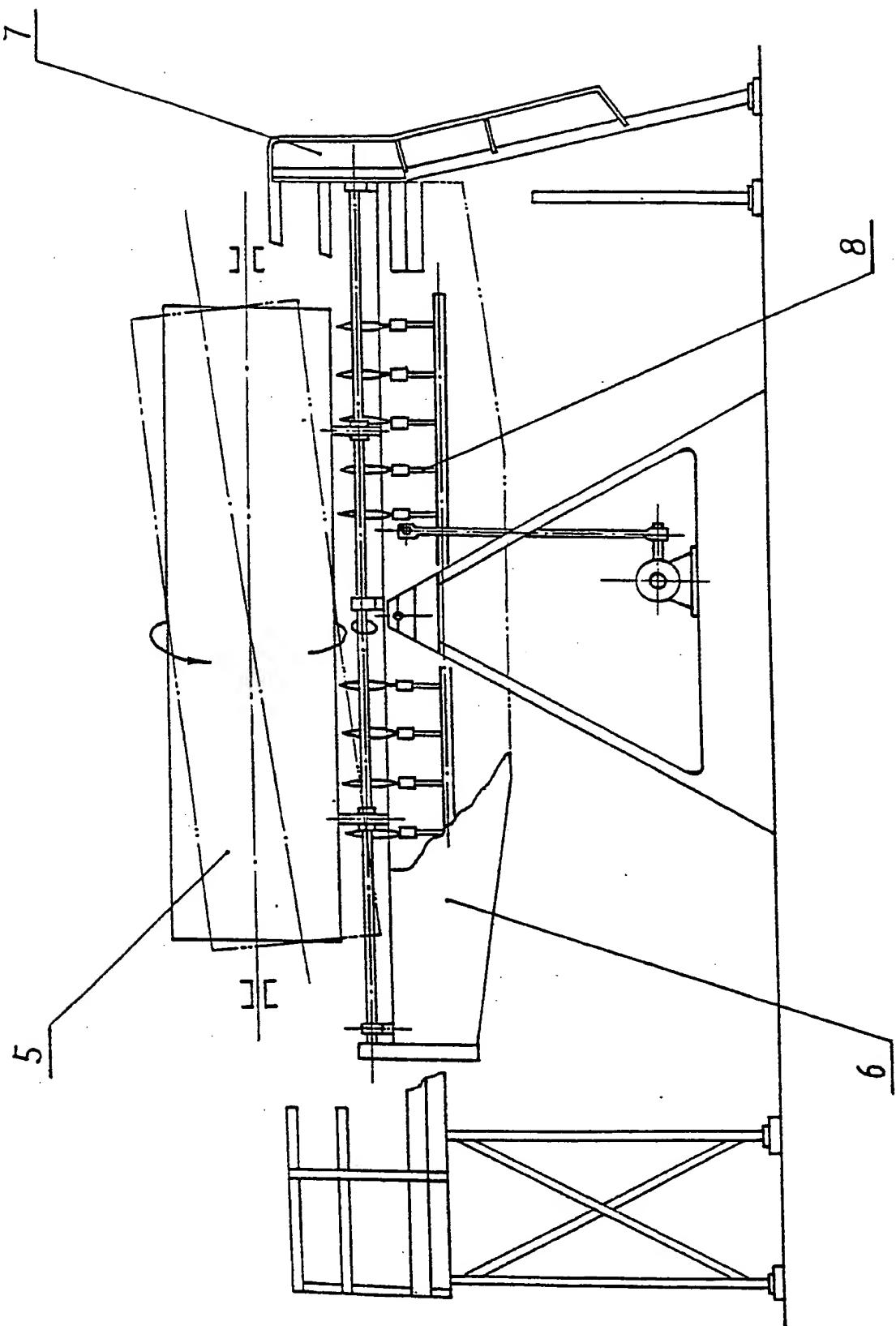


FIG 2



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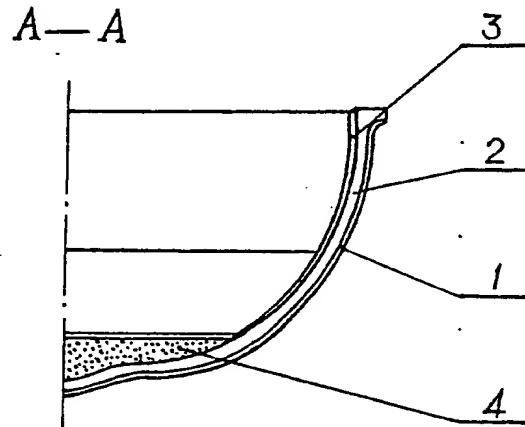


FIG 18



EP 88305814.1

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
A	DATABASE WPI, no. 80-52 472, Derwent Publications, Ltd., London, GB & JP-A-55 077 527 (BRIDGESTONE TIRE K.K.) 12-06-1980 * Abstract * --	1, 3, 5, 6	B 23 B 27/20 B 63 B 5/24
D, A	US - A - 3 176 055 (LOOS) * Claim * --	1, 5, 7	
A	DE - A1 - 2 411 628 (RUBEROIDWERKE AG) * Claim 1 * ----	1, 5	
			TECHNICAL FIELDS SEARCHED (Int. Cl 4)
			B 32 B B 63 B
The present search report has been drawn up for all claims			
Place of search VIENNA	Date of completion of the search 11-12-1989	Examiner WEIGERSTORFER	
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone	T : theory or principle underlying the invention		
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P : intermediate document	document		